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ABSTRACT

The major emphasis of this study is to identify and counsel seventh, eighth, and young ninth-grade students who are mathematically gifted. Such youngsters were identified as those scoring 600 or above on the mathematics section of the Scholastic Aptitude Test (SAT). This paper summarizes what has been learned about the career interests of mathematically precocious youth and how these measures have provided insights into (1) the nature of mathematical precocity, (2) the differences between the sexes in this respect, and (3) the success of various educational intervention procedures. Career interest were measured by a checklist of six categories of occupations and a questionnaire which asked the student to list his current career choices. The Allport-Vernon-Lindzey Study of Values was used to assess the values of the students. Results of the vocational interest study indicated that the majority of these students had strong interests in mathematical and scientific careers. The relationship of values to performance on the mathematics test was complex. The author elaborated on the findings. (Author/BW)

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Values and Career Interests of Mathematically Precocious Youth

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The major emphasis of the Study of Mathematically and Scientifically Precocious Youth is to identify and counsel seventh, eighth, and young ninth grade students who have a great deal of talent in mathematics. To identify these mathematically talented youngsters who could benefit from educational counseling, two annual contests in mathematics have been held at The Johns Hopkins University using the mathematics section of the Scholastic Aptitude Test (SAT). Students who scored 600 or above on the SAT-M were considered precocious achievers.

The goals of the counseling program are to enrich educational experiences, increase opportunities, and telescope the time spent in high school when appropriate for these students. The intervention methods which have proven successful with these students have included: taking college courses in summer, at night, and on released time from school while still in high school; taking advanced course work in mathematics and science at a high school while remaining in grade for other subjects; or independent study at a rapid pace under the guidance of a teacher or tutor in place of the in-grade mathematics course work.

In order to decide which methods of facilitation might be best for a given individual, we felt we needed to learn a great deal about the abilities, values, and interests of each individual we counseled. Therefore winners and near-winners of the annual competitions have been tested on additional cognitive and affective measures.

This paper summarizes what we have learned about the career interests and values of mathematically precocious youth and how these measures have provided insights into the nature of mathematical precocity, the differences between the sexes in this respect, and the success of various educational intervention procedures.

The measures of career interest used were a one-paper checklist of six categories of occupations from John Holland's (1970) Self-directed Search vocational instrument and a questionnaire which asked the student to list his current career choices. The Holland Checklist was scored by assigning the code of the occupational category most frequently checked. The six categories are as follows: investigative, artistic, enterprising, realistic, social, and conventional. The first-choice occupations on the questionnaire were also assigned Holland codes (Viernstein, 1972). The investigative category of occupations was the one expected to be most related to precocity in mathematics.

The Allport-Vernon-Lindzey Study of Values (SV) was used to assess the values of the students. The SV yields six scores indicating strength of preference for each of six evaluative areas: theoretical, economic, aesthetic, social, political, and religious. The theoretical scale was expected to be the one most associated with scientific and mathematical interests. Other researchers (MacKinnon, 1962; Hall and MacKinnon, 1969; Warren and Herst, 1960; and Southern and Plant, 1968) have reported a relationship between creativity and high scores on the theoretical and aesthetic scales.

In order to better interpret the results of these measures of values and interests for the high-scoring students, each of these tests was administered to one of the larger groups of contestants. In the 1972 contest the Holland

checklist was administered to 396 students. In 1973 the Study of Values was administered to 667 contestants.

Career Interests

In brief, the results of the study of vocational interests of the 1972 contestants indicated that the majority of these students had strong interests in mathematical and scientific careers as evidenced by their preference for investigative occupations on the checklist and the questionnaire. Boys as a group favored investigative occupations more than girls. The second most frequently preferred category of occupations on the checklist was artistic. Girls--particularly seventh grade girls--preferred this category more than boys. However, few girls or boys listed artistic occupations on their questionnaires. Girls more than boys indicated interest in occupations of a social nature. Boys more than girls showed preferences for enterprising and realistic occupations. Conventional occupations were not popular with either boys or girls. The greatest agreement between first-choice occupations on the questionnaire and the checklist was for the investigative occupations.

Sex Differences, Career Interests, and Performance on SAT-M

In the large group of 1972 contestants, the relationship of career interests to performance on the SAT-M seems complex. It appears that interest in investigative occupations is somewhat related to mathematics performance for girls but not for boys. Thus, girls who score high on the SAT-M were more likely to prefer the investigative occupations than were girls who scored low. This would seem consistent with other studies of sex difference in mathematics ability, attitudes and career interests. What is perhaps surprising in the current study is that while a sizeable number of the girls who entered the contest did indeed have investigative career preferences which are typically considered masculine, no girl exhibited the high level of pre-

cocity in mathematics which was found for a sizeable number of boys. Nineteen percent of the boys scored above the highest scoring female.

Values

Our understanding of the nature of mathematical precocity and the sex differences found therein can be somewhat enhanced by considering the additional information gleaned from our 1973 study of values of gifted students who enter a mathematics contest.

The rank order of the values by mean score on each of the six scales for each grade and sex group are shown in Table 2. The differences between

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Insert Table 2 about here

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the sexes are highly significant. Girls scored higher on the social, religious, and artistic scales. Boys were higher on the theoretical, economic, and political scales.

When mean scores for both sexes are compared with the mean scores of high school girls and boys, it was found that the girls and boys in the contest have similar profiles to high school girls and boys, respectively. The greatest differences between the groups were on the theoretical and religious scales. The gifted contestants score higher on the theoretical and lower on the religious scales than the average group of high school students.

The distribution of the students in the contest by grade and sex and highest value on the SV are shown in Table 3. The social value was the

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Insert Table 3 about here

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highest value for the largest proportion of seventh and eighth grade girls. The largest proportions of seventh and eighth grade boys scored highest on the theoretical value.

Sex Differences, Values, and Performance on the SAT-M

In the larger group, the relationship of values to performance on the mathematics test was complex. A comparison of high and low scorers on the mathematics test by highest value indicate that girls who performed well on the mathematics test were more apt to have highest economic, aesthetic, or theoretical values. Girls who scored highest on the religious value were more apt to score low than high in the mathematics contest. Although the number of seventh grade boys who scored highest on the religious value was small, they had the highest SAT-M mean score of any value group. Eighth grade boys who scored highest on the theoretical value had the highest mean score on the SAT-M.

Career Interests, Values, and Precocity

Since so few girls scored high on the SAT-M, we will consider only the high scoring boys from both contests (hereafter to be called the "winners") in our analysis of career interests, values, and precocity.

The groups of winners from the 1972 and 1973 contests do not differ from each other in their strong preference for investigative careers and high theoretical orientations. The major difference between the winners from the two years is in preference for the religious value. Five of the 1973 winners scored highest on the religious value, while none of the 1972 winners did so. Differences between the mean scores of each of the sex values for winners of both years were significant for the religious value. Although the recruitment

procedures for contestants did differ somewhat from year to year, there is no obvious explanation for this difference.

Boys who were considered precocious in their knowledge of mathematics did differ significantly from the less precocious contestants in several ways. Table 6 shows the distributions of winners and all male contestants in 1972

Insert Table 6 about here

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by occupational preferences on the checklist. A somewhat greater proportion of the winners prefer the investigative occupations than the boys as a whole. What is more important is that boys who were deemed precocious showed far greater strength and consistency of investigative preferences as evidenced by the agreement between the checklist and the questionnaire. Sixty-nine percent of the winners preferred investigative occupations on both measures as compared with 46 percent of the boys in the 1972 contest as a whole.

Table 8 shows the distribution of the winners and 1973 male contestants

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Insert Table 8 about here

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by highest value score. The differences in value orientations between the winners and the contestants as a whole was more dramatic than differences in career orientations. One might consider this an indication of stronger consistency in commitment to scientific and mathematical values and interests.

While many talented young people who enter a mathematics contest are interested in scientific careers, a much smaller percentage of students in such a contest have the strong theoretical orientation which one would

expect of the "pure" scientist. A sizeable number of boys have high economic or political values. Thus their interest in investigative occupations may reflect other motivations. One might suppose that students interested in scientific careers who have economic or political values may value scientific careers because of their power, prestige status, and economic remuneration. Those who were high on the social value and who are interested in investigative careers may view these career areas in terms of their possible contributions to the improvement of the quality of life.

Students who exhibit the most precocious achievement in the area of mathematics as evidenced by high scores on the SAT-M appear to be more strongly oriented towards mathematical and scientific careers and to value theoretical pursuits more than other contestants. It seems likely that their strong interests and orientations in these directions have contributed to their precocious development.

Within the 1972 winners group the relationship of theoretical values to performance on cognitive measures was far greater a measure of science knowledge than for other cognitive measures.

Intervention and Educational Facilitation

Most boys who have been identified as precocious in mathematics report that they have become accelerated in their knowledge of mathematics by working on their own--sometimes systematically with the help of a teacher or parent--sometimes just by working with mathematics puzzles and games. Since the majority of these students score high on theoretical values and investigative interests, it seems that these orientations have motivated them to seek this stimulation.

Since the winners are fairly homogeneous in terms of values and attitudes, we see few differences between those who wish to further accelerate

their educational progress by various means and those who are less interested in becoming more accelerated.

Twenty boys from the winners group have taken a college course in mathematics or computer science or both. These students do not differ signficantly from the remaining high scorers in either theoretical orientation or investigative vocational interests. Sixty percent of the twenty scored highest on the theoretical value and about 68 percent preferred investigative occupations on the checklist. None of the boys who have taken college courses have been high on the social value.

To date all the students who have taken college courses have performed well in these classes regardless of their values or career interests. Thus if a talented student is motivated enough to want to accelerate his educational progress in mathematics he is apt to be successful even if his motivation does not result from strong theoretical and investigative interests. What is clear is that students who have become precocious in their knowledge of mathematics and who seek further acceleration are most likely to be those with scientific values and goals.

Other intervention measures have proven successful with talented students. By in large, students who score high on theoretical values are more anxious to accelerate their progress in school.

Conclusions

In conclusion, students who have unusually high level talent in mathematics and who are able to benefit from special educational facilitation such as advanced course work and acceleration tend to have values and interests which are highly consistent with their abilities. It would appear that many already have personalities which resemble those of mathematicians and

scientists. Students who have similar cognitive abilities but do not have the same values and career interests are less apt to seek out or accept special advancement in the areas of mathematics and science. Since girls are more apt to have social and aesthetic interests, it would seem that values and interests are at least partially related to the fact that so few girls become accelerated in their mathematics education.

We hope to work closely with the winners over the coming years to encourage their continued achievement. Among the winners there are some students who are not strongly oriented towards theoretical and investigative goals. It will be interesting to see to what extent these students will continue to pursue science and mathematics as compared with the others and to what extent the values and career interests of these students will change over the coming years. We can now only wait to see how many of these youngsters will become the creative scientists and mathematicians of the future.

Table 2: Rank Order of the Six Values of the Study of Values for 655 Students in the 1983 Mathematics Contest

Girls			Boys		
Grade 7	Grade 8	All	Grade 7	Grade 8	All
S	S	S	T	T	T
P	P	P	P	P	P
A	R	T	E	E	E
T	T	R	S	S	S
R	A	A	R	R	R
E	E	E	A	A	A

Key

T = Theoretical S = Social

E = Economic P = Political

A = Aesthetic R = Religious

Table 3: Percent of Students by their Highest Value on the Study of Values for 655 Students in the 1973 Mathematics Contest

		No.	T*	E	A	S	P	R
Girls	Grade 7	84	11.9	9.5	7.1	42.8	10.7	17.9
	Grade 8	155	16.1	1.9	16.1	32.9	12.3	20.6
	All	239	14.6	4.6	13.0	36.4	11.7	19.7
Boys	Grade 7	135	40.7	9.6	3.7	10.4	25.9	9.6
	Grade 8	281	34.5	15.3	5.0	15.3	19.2	10.7
	All	416	36.5	13.5	4.6	13.7	21.4	10.3

*Key

T = Theoretical
E = Economic
A = Aesthetic
S = Social
P = Political
R = Religious

Table 6: Percent of Boys in the 1972 Mathematics Contest and the Winners from the 1972 and 1973 Contests[a] by Highest Holland Code

	Total No.	I*	A	E	R	S	C
All Boys 1972	222	56.6	11.0	10.9	10.8	7.3	3.4
Winners 1972	35	64.7	8.5	0.9	14.8	2.9	8.1
New Winners 1973	36	68.1	4.2	5.6	6.0	3.7	12.5
All Winners 1973	47	71.3	3.2	5.3	7.8	2.8	9.5
Combined Winners	71	66.9	6.3	4.0	9.9	3.3	9.9

*Key

I = Investigative
A = Artistic
E = Enterprising
R = Realistic
S = Social
C = Conventional

[a] The Holland Checklist was not administered to all of the 1973 contestants. This data was available only for the winners in the 1973 contest.

Table 8: Percent of Boys in the 1973 Mathematics Contest and Winners from the 1972[a] and 1973 Contests by Highest Value on The Study of Values

	Total No.	T*	E	A	S	P	R
All Boys 1973	416	36.5	13.5	4.6	13.7	21.4	10.3
New Winners 1973	36	55.6	5.6	2.8	2.8	19.4	13.9
All Winners 1973	47	57.4	6.4	2.1	6.4	17.0	10.6
Winners 1972	35	62.9	14.3	5.7	8.6	8.6	--
Combined Winners	71	59.2	9.9	4.2	5.6	14.1	7.0

Key

T = Theoretical
E = Economic
A = Aesthetic
S = Social
P = Political
R = Religious

[a] The Study of Values was not administered to all of the 1972 contestants. This data was available only for the winners in the 1972 contest.